

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau



NO SUPPON SLIPS

6

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>5</sup> : B07B 1/46, 1/48, B01D 29/01, 29/44	A1	(11) International Publication Number: WO 94/23849
		(43) International Publication Date: 27 October 1994 (27.10.94)

(21) International Application Number: PCT/EP94/01118

(22) International Filing Date: 8 April 1994 (08.04.94)

(30) Priority Data:  
08/045,489 8 April 1993 (08.04.93) US  
08/056,123 30 April 1993 (30.04.93) US

(71) Applicants (for all designated States except US): ENVIRONMENTAL PROCEDURES, INC. [US/US]; 6829 Flintlock, Houston, TX 77040 (US). LUCAS, Brian, Ronald [GB/GB]; 135 Westhall Road, Warlingham, Surrey CR6 9HJ (GB).

(72) Inventors; and

5) Inventors/Applicants (for US only): LEONE, Vincent, D., Sr. [US/US]; 12146 Burgoyne Street, Houston, TX 77077 (US). WALKER, Jeffrey, E. [US/US]; 107 Valley View, Lafayette, LA 70501 (US). DUGAL, Robert, L. [US/US]; 403 Cypress Cove, Youngsville, LA 70592 (US).

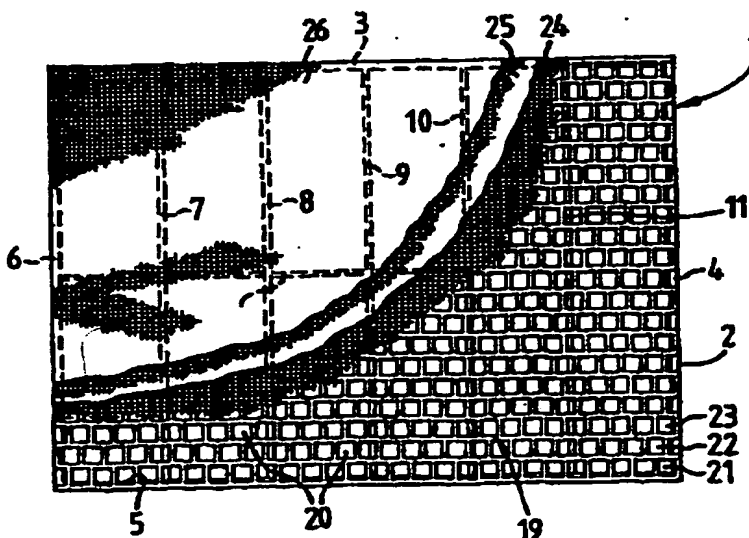
(74) Agent: LUCAS, Brian, Ronald; Lucas & Co., 135 Westhall Road, Warlingham, Surrey CR6 9HJ (GB).

(81) Designated States: AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, ES, FI, GB, GE, HU, JP, KG, KP, KR, KZ, LK, LU, LV, MD, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: SCREEN FOR SEPARATING SOLIDS FROM DRILLING FLUID



(57) Abstract.

A screen (1) for separating solids from drilling fluids comprises an outer frame (2) and a plurality of support members (7, 8, 9, 10, 11). A sheet (19) of perforate material is bonded to both the outer frame (2) and the support members (7, 8, 9, 10, 11) and three layers of mesh (24, 25, 26) are bonded to the sheet (19). In use, the screen (1) is secured in a vibratory shaker. Preferred embodiments have a high life expectancy and high conductance. Furthermore, accidental damage can be contained and repaired if desired.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

- 1 -

**SCREEN FOR SEPARATING SOLIDS FROM DRILLING FLUID**

This invention relates to a screen for separating solids from drilling fluid, a vibratory shaker fitted  
5 with such a screen and a sheet of perforate material for use in said screen.

Drilling fluid is used to maintain the tip of a drill cool and to carry solids to the surface of the wellbore. Once at the surface the solids are removed  
10 from the drilling fluid which is reused.

One piece of apparatus commonly used to separate the solids from the drilling fluid is a vibratory shaker.

Vibratory shakers generally comprise a frame which,  
15 in use, oscillates back and forth.

Shortly before use a screen is unrolled and placed on the frames. The screen remains in place until it fails at which time the screen is replaced. Because of the highly abrasive nature of the solids in drilling  
20 fluid the life of the screen is relatively short.

In order to increase screen life manufacturers have resorted to the use of screens fabricated from large diameter threads which are interwoven to form a grid. Whilst this prolongs screen life (typically 2 - 3 days)  
25 the conductance (volumetric throughput) of the screen is severely restricted.

In an attempt to increase conductance it has been proposed to fabricate a screen from a perforated plate to which was bonded a sheet of relatively fine mesh.  
30 This solution provided excellent conductance. However, the screens themselves were extremely delicate and often needed replacement every 1-2 days.

It should be noted that in both the above embodiments the screen is simply unrolled and placed on the  
35 frame before use.

- 2 -

The aim of at least preferred embodiments of the present invention is to provide a screen which has a relatively high conductance and a relatively high working life.

5       According to the present invention there is provided a screen for separating solids from drilling fluid, which screen is characterized in that it comprises an outer frame, at least one support member extending across said outer frame, a sheet of perforate material  
10       secured to said outer frame and said support member, and at least one sheet of mesh secured to said sheet of perforate material.

Preferably, a plurality of support members extend across said outer frame and said sheet of perforate  
15       material is secured to each. This has quite remarkable advantages. In particular, in a preferred embodiment the screen had a typical life of from 7 to 10 days.

Preferably, the support members are disposed at centres between 140 and 170 mm.

20       The present invention also has a further significant advantage. In particular, if a prior art screen was inadvertently pierced, for example by dropping a tool on the screen, the damage would quickly spread over the entire screen rendering it useless in a matter of  
25       minutes. In contrast, with screens in accordance with the present invention the damage can be confined between adjacent support members or between a support member and the frame. Such a small area can rapidly be patched albeit at the cost of some throughput.

30       In order to help ensure that all the contaminated drilling fluid which is introduced onto the screen is treated generally uniformly, the sheet preferably comprises two sets of ribs which are inclined to opposite sides of said at least one support member.

35       Typically, said ribs will intersect at an angle of

- 3 -

from 20° to 90°, and preferably 60°.

Advantageously, said sheet includes transverse ribs which extend across said screen generally perpendicular to said support members and which pass through the  
5 intersection of said ribs of said two sets of ribs.

Another aspect of the present invention provides a vibratory shaker fitted with a screen in accordance with the invention.

The present invention also provides in or for use  
10 in a screen according to the present invention, a sheet of perforate material comprising two edges and two sets of ribs which are inclined to one another and to said edges and at least one sheet of mesh secured thereto.

Preferably, said ribs intersect at an angle of from  
15 20° to 90°.

Advantageously, said edges are provided with members for attaching the sheet to a vibratory shaker.

20

25

30

35

- 4 -

For a better understanding of the invention reference will now be made, by way of example, to the accompanying drawings, in which:-

Figure 1 is a perspective view showing the bottom  
5 of one embodiment of a screen in accordance with the present invention;

Figure 2 is a partially cut away top plan view of the screen shown in Figure 1;

Figure 3 is a bottom plan view of a second  
10 embodiment of a screen in accordance with the present invention; and

Figure 4 is a top plan view, to an enlarged scale, of part of the screen encircled and identified by the reference letter "A" in Figure 3.

15 Referring to the drawings, there is shown a screen which is generally identified by reference number 1. The screen 1 comprises an outer frame 2 which is generally rectangular and comprises four frame members 3, 4, 5 and 6.

20 The frame member 3 and 5 are each 107cm (42.35 inches) long whilst the frame members 4 and 6 are each 74cm (29 inches) long. All the frame members 3, 4, 5, 6 have a 2.54cm x 2.54cm (1 inch x 1 inch) cross-section.

Five support members 7, 8, 9, 10, 11 extend  
25 between the frame members 3 and 5 and define six bays 12, 13, 14, 15, 16, 17 of equal width.

A rod 18 extends from the frame member 4 to the frame member 6 and is attached to each of the support members 7, 8, 9, 10 and 11 to maintain them properly  
30 spaced from one another.

A sheet 19 of perforate material is bonded to the frame members 3, 4, 5, 6 and the support members 7, 8, 9, 10, 11. The sheet 19 is made from steel and comprises a plurality of square holes 20 which are each 2.54cm x  
35 2.54cm (1 inch x 1 inch). The square holes 20 are ar-

- 5 -

5 ranged in rows, for examples rows 21, 22, 23. The square holes 20 in each row 21, 22, 23 are separated by approximately 3mm (1\8 inch) and the rows 21, 22, 23 themselves are separate by approximately 3mm (1/8 inch). The square holes in alternate rows are aligned with one another but are offset from the square holes in adjacent rows as shown.

10 The upper surface of the sheet 19 is covered with an adhesive and a first sheet of mesh 24 is bonded thereto. If desired further sheets of mesh 25, 26 may be bonded to the sheet 19 at the same time as the first sheet of mesh 24. Typically, the mesh 23, 24, 25 will have from 40 to 270 openings per linear inch (16 to 106 openings per linear cm) with 60 to 180 openings per linear inch (24 to 71 openings per linear cm) being more usual.

20 In use, several screens 1 are simply laid between the side rails in the base of a vibratory shaker and secured in place. The vibratory shaker is then set in motion. When contaminated drilling fluid is introduced onto the screens the drilling fluid passes through the screens whilst the solids are retained on the screen in the usual manner. The screens are normally inclined by a few degrees so that the solids travel to the lower end of the screen and fall into a hopper for disposal or further processing. It should be noted that the screens 1 are arranged so that their support members 7, 8, 9, 10 and 11 extend along the vibratory shaker in the direct of travel of the solids..

30 It will be appreciated that existing vibratory shakers are provided with support beams which are welded in place. Ideally these should be removed to obtain full conductance. However, we have found that the screens 1 may simply be laid over the support beams if desired.

35 Various modifications to the embodiment described



- 6 -

are envisaged. For example, whilst the sheet 19 is preferably bonded to the frame members, 3, 4, 5, 6 and the support members 7, 8, 9, 10, 11 it could also be secured by, for example continuous welding, spot welding, rivets and screws.

Turning again to Figure 2, it has been found that, in use, contaminated drilling fluid tends to move linearly along the screen 1 with little movement transverse to the direction of vibration. As a result, with the exception of when it passes over the metal strips between the rows 21, 22; 22, 23 some contaminated drilling fluid is nearly always over a square hole. In contrast, a small proportion of the drilling fluid is only over a square hole for part of the time. In particular, the small proportion which passes over the ribs between the rows 21, 22; 22, 23 and over the ribs between adjacent squares in the same row. Although this problem is partially mitigated by offsetting the squares in alternate rows as disclosed in Figures 1 and 2, the situation is not entirely satisfactory.

The screen shown in Figures 3 and 4 addresses this problem. In Figures 3 and 4 parts having similar function to parts shown in Figures 1 and 2 have been given the same reference numerals increased by 100.

As shown in Figures 3 and 4 a plurality of triangular openings 127, 128, 129, 130 are punched out of the sheet 119. The triangular openings 127, 128 are arranged in rows 121, 122, 123. Adjacent triangular openings 127, 128 in each row are inverted relative to one another whilst the triangular openings 128 and 129 in adjacent rows 121, 122 are arranged so that either their bases 133 or their apices 134 contact one another. This construction results in the formation of rows of diagonal ribs 131 and 132 which are inclined to opposite sides of the support members 107, 108 and which intersect one

- 7 -

another at an angle  $\alpha$  of approximately  $60^\circ$ .

It will be noted that the bases 133 of the triangles extend across the screen 101 and form traverse ribs 135 which are generally perpendicular to the support members 107, 108. In use, contaminated drilling fluid passes over the screen 101 in the direction of the arrows D. It will be appreciated that the contaminated drilling fluid is above one or other triangular opening for much of the time whilst it traverses the screen 101.

Various modification to the arrangement shown in Figures 3 and 4 are envisaged, for example the angle could vary from  $20^\circ$  to  $90^\circ$ . In addition, the bases 133 could conceivably be dispensed with although this would significantly weaken the sheet 119. The ribs 131, 132 in each set of ribs are preferably equally inclined to opposite sides of the support members 107, 108 although this is not absolutely essential.

It would also be possible for the sheet 119, together with layer(s) of mesh 124 to be sold in sheets or in rolls for use in conventional vibratory shakers. When sold for use in conventional vibratory shakers opposite edges of the sheet 119 may be provided with members for attaching the sheet 119 to the vibratory shaker. Such members may be, for example of [-shape cross-section.

25

30

35

- 8 -

**CLAIMS**

1. A screen (1) for separating solids from drilling fluid, which screen is characterized in that it comprises an outer frame (2), at least one support member  
5 (7, 8, 9, 10, 11) extending across said outer frame (2), a sheet (19) of perforate material secured to said outer frame (2) and said support member (7, 8, 9, 10, 11), and at least one sheet of mesh (24, 25, 26) secured to said sheet (19) of perforate material.
- 10 2. A screen as claimed in Claim 1, characterized in that a plurality of support members (7, 8, 9, 10, 11) extend across said outer frame (2) and said sheet (19) of perforate material is secured to each.
3. A screen as claimed in Claim 2, wherein said support members (7, 8, 9, 10, 11) are disposed at centres  
15 between 140 and 170 mm.
4. A screen as claimed in any preceding Claim, characterized in that said sheet (119) comprises two sets of ribs (131, 132) which are inclined to opposite side of  
20 said at least one support member (107, 108).
5. A screen as claimed in Claim 4, characterized in that said ribs (131, 132) intersect at an angle  $\alpha$  of from  $20^{\circ}$  to  $90^{\circ}$ .
6. A screen as claimed in Claim 5, characterized in  
25 that angle  $\alpha$  is  $60^{\circ}$ .
7. A screen as claimed in Claim 4, 5 or 6, characterized in that said sheet (119) includes transverse ribs which extend across said screen (101) generally perpendicular to said support members (107, 108) and which  
30 passes through the intersection of said ribs of said two sets of ribs (131, 132).
8. A vibratory shaker fitted with a screen (1) as claimed in any preceding Claim.
9. In or for use in a screen as claimed in Claim 1, a  
35 sheet of perforate material comprising two edges and two

- 9 -

sets of ribs (131, 132) which are inclined to one another and to said edges, and at least one sheet of mesh secured thereto.

10. A sheet as claimed in Claim 9, wherein said ribs (131, 132) intersect at an angle  $\alpha$  of from  $20^{\circ}$  to  $90^{\circ}$ .

11. A sheet as claimed in Claim 9 or 10, wherein said edges are provided with members for attaching the sheet (119) to a vibratory shaker.

10

\* \* \*

15

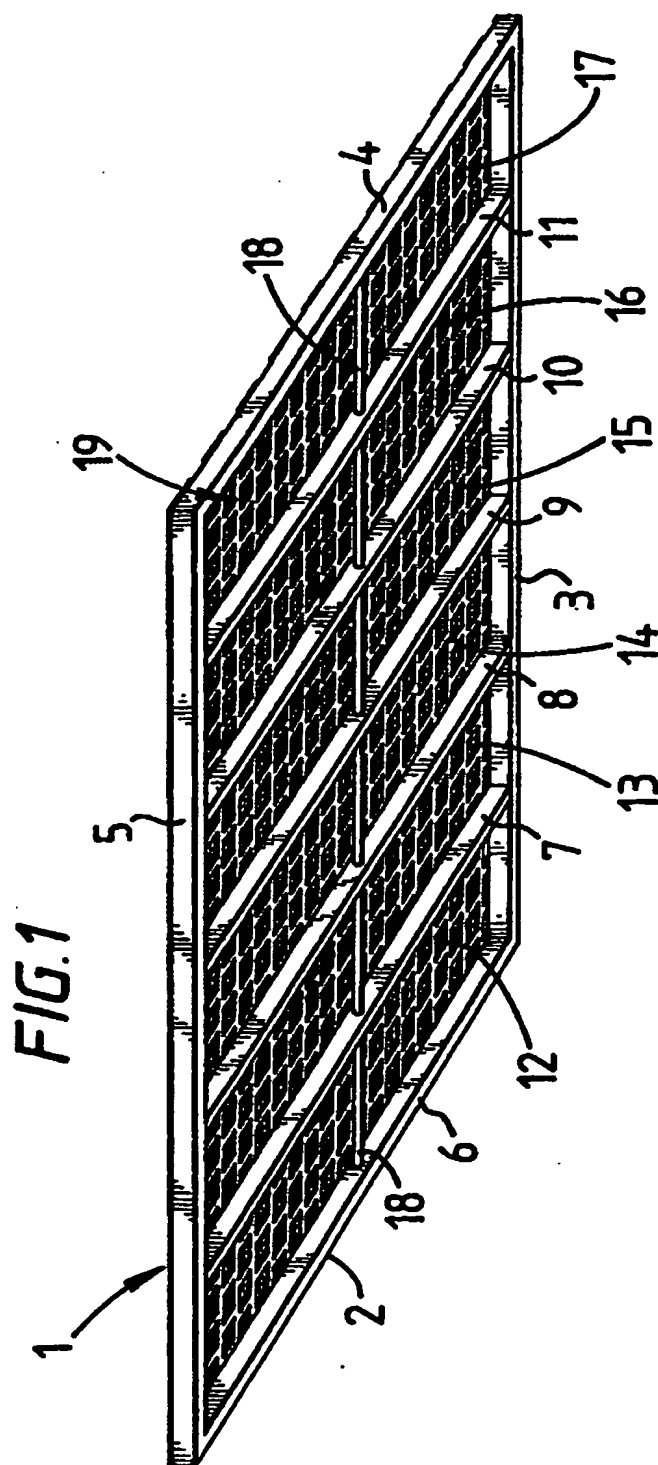
20

25

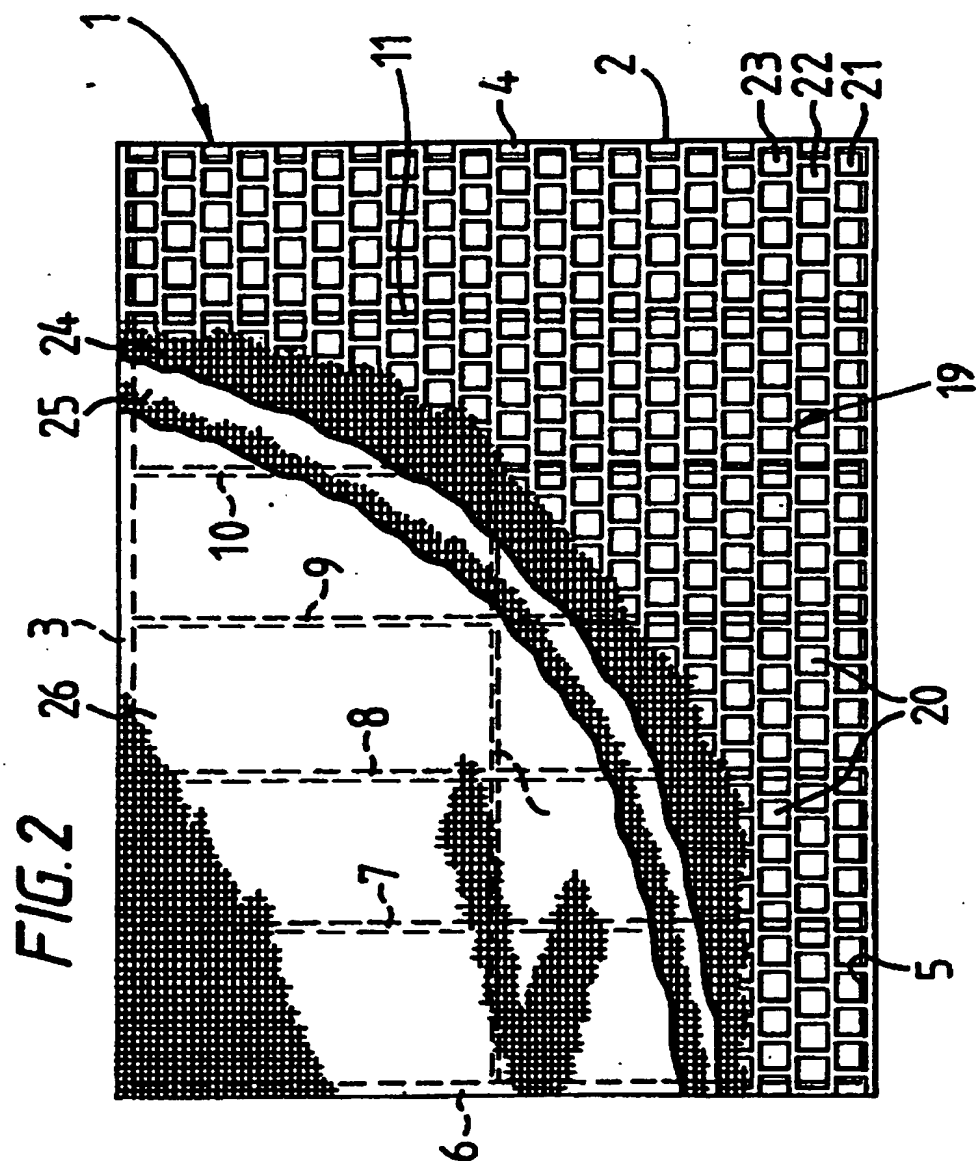
30

35

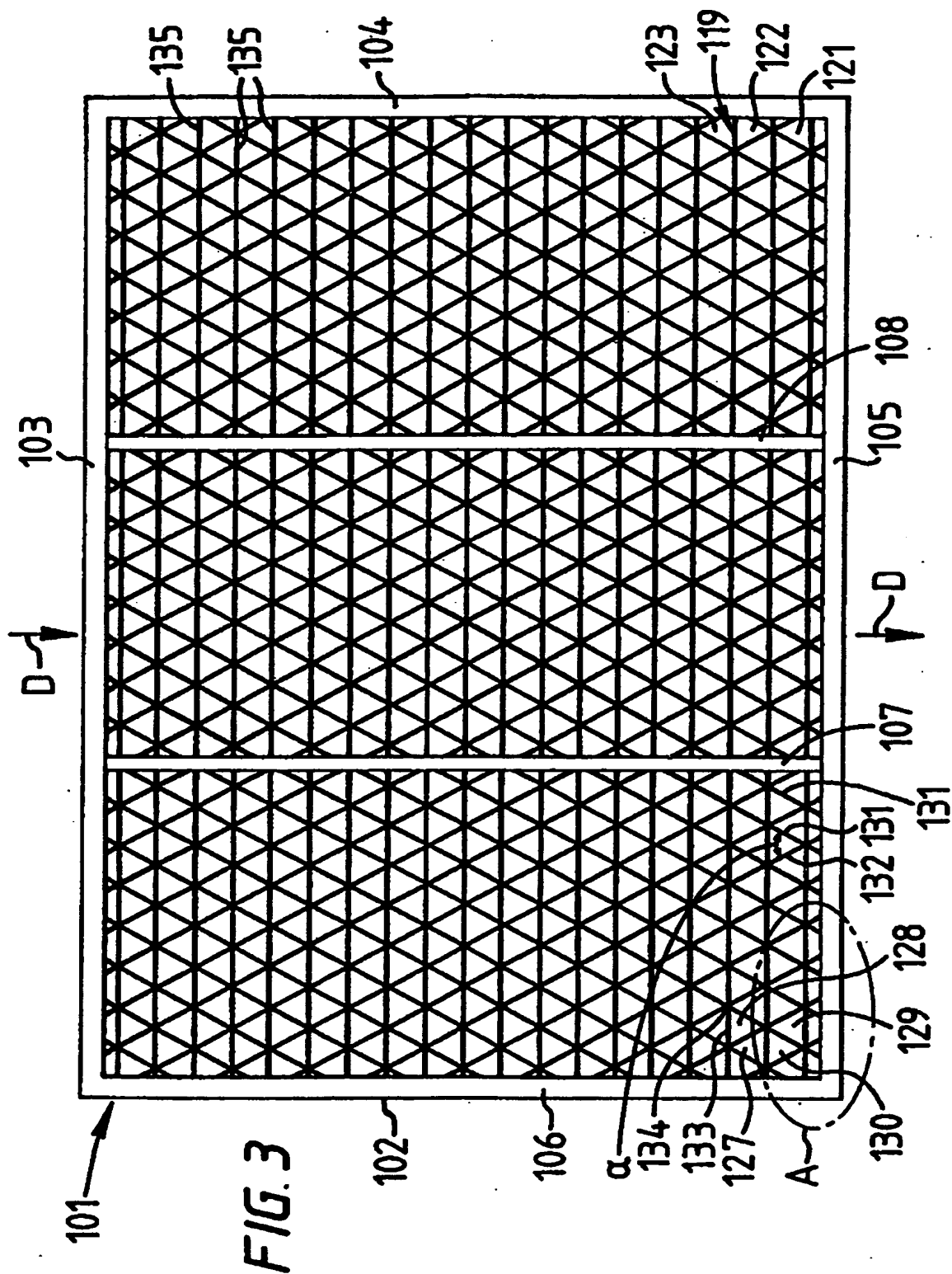
1/4



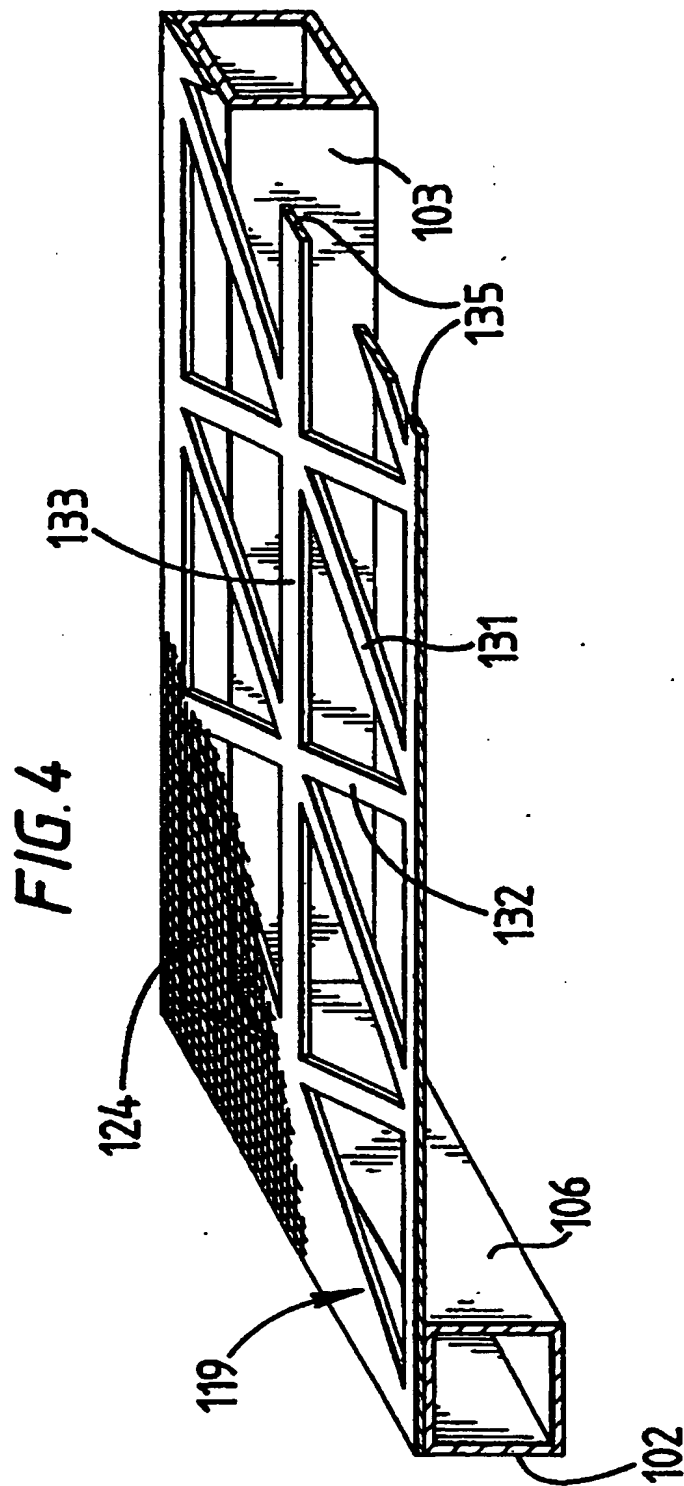
2/4



3/4



4/4





# INTERNATIONAL SEARCH REPORT

Inter. Appl. No.  
PCT/EP 94/01118

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 5 B07B1/46 B07B1/48 B01D29/01 B01D29/44

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 5 B07B B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A,4 575 421 (J. DERRICK) 11 March 1986 see column 2, line 23 - column 3, line 39 see figures	1-3,8
Y	DE,A,22 56 272 (KRALOVOPOLSKA STROJIRNA) 24 May 1973 see page 4, line 1 - page 5, line 19 see claims see figures	1-3,8
A	EP,A,0 169 698 (THULE) 29 January 1986 see page 14, line 4 - line 16 see page 15, line 26 - page 16, line 9 see figures 1-3,9	1-3,8

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

2 August 1994

Date of mailing of the international search report

30.08.94

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3016

Authorized officer

Laval, J

# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/EP 94/01118

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4575421	11-03-86	NONE	
DE-A-2256272	24-05-73	GB-A- 1412975	05-11-75
EP-A-0169698	29-01-86	AU-B- 573868	23-06-88
		AU-A- 4520185	23-01-86
		CA-A- 1274189	18-09-90
		GB-A, B 2161715	22-01-86
		GB-A, B 2162091	29-01-86
		GB-A, B 2175222	26-11-86
		JP-A- 61038607	24-02-86
		US-A- 4728422	01-03-88
DE-A-2630282	02-06-77	AT-A- 336525	10-05-77
FR-A-2407026	25-05-79	GB-A- 1578948	12-11-80
		DE-A- 2846342	03-05-79
		JP-C- 1409284	24-11-87
		JP-A- 54074557	14-06-79
		JP-B- 62011911	16-03-87